DOCUMENT RESUME

ED 414 256 SP 037 657

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TITLE Using Graphic Organizers To Teach Vocabulary: How Does Available Research Inform Mathematics Instruction?
PUB DATE 1997-00-00
NOTE 9p.
PUB TYPE Information Analyses (070)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Concept Formation; Content Area Reading; *Elementary School Mathematics; Elementary School Students; Elementary Secondary Education; Fundamental Concepts; *Mathematics Instruction; *Secondary School Mathematics; Secondary School Students; Teaching Methods; *Vocabulary Development
IDENTIFIERS *Graphic Organizers

ABSTRACT

This study reviewed the literature on graphic organizers to investigate effective ways to teach the vocabulary of mathematics, noting that mathematics is recognized as the most difficult content area reading material. The literature indicates that effective use of graphic organizers can help develop conceptual understanding by promoting student involvement and emphasizing deep processing of words. Graphic organizers serve as retrieval cues for information and facilitate higher level thinking. Researchers have found graphic organizers particularly effective for teaching technical vocabulary, though their use may require an existing schema for the concept under study. One research study combined a discussion model for understanding new words (Frayer, Frederick & Klausmeier, 1969) with Concept of Definition (Schwartz, 1988), a graphic form with similar features. Researchers implemented this adapted model with fourth graders in a measurement unit. When tested against a definition-only model, it effectively increased the use of mathematical vocabulary in student writing. Four issues needing further study are: (1) which research designs provide the best information regarding the efficacy of graphic organizers in teaching mathematics vocabulary; (2) which graphic organizers effectively teach mathematics vocabulary; (3) how graphic organizers compare to other methods of teaching mathematics vocabulary at various grade levels; and (4) what strategies best help teachers incorporate the use of graphic organizers into their instruction. (Contains 17 references). (SM)

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Using Graphic Organizers to Teach Vocabulary: How Does Available Research Inform Mathematics Instruction?

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Abstract

The need for vocabulary knowledge in the development of mathematics concepts is well documented. Although graphic organizers have been found to be effective in helping students learn vocabulary in informational text, the available research on their use in teaching mathematics vocabulary is minimal. The purpose of this paper is twofold: to summarize available research on the use of graphic organizers in vocabulary instruction and to make recommendations for research on their use in developing mathematics vocabulary.

Using Graphic Organizers to Teach Vocabulary: How Does Available Research Inform Mathematics Instruction?

The need for rich and meaningful vocabulary knowledge in developing concepts in content areas is documented by research and is generally accepted by classroom teachers (Monroe & Panchyshyn, 1995-1996). Mathematics is recognized as the most difficult content area reading material, "with more concepts per word, per sentence, and per paragraph than any other area" (Schell, 1982, p. 544). Because vocabulary represents and provides access to concepts, instruction in the vocabulary of mathematics cannot be incidental. It requires careful attention within the school curriculum (Gawned, 1990). Teachers need assistance in knowing how to provide meaningful vocabulary instruction in mathematics.

In an ongoing effort to find effective ways to teach the vocabulary of mathematics, the author conducted a review of the literature on graphic organizers. Although only limited research was found on the use of graphic organizers in mathematics instruction (Monroe & Pendergrass, 1997), there was evidence of their effectiveness in helping students learn vocabulary in informational text. In this paper the author summarizes available research on the use of graphic organizers in vocabulary instruction and makes recommendations for research on their use in developing mathematics vocabulary.

Graphic Organizers in Vocabulary Instruction

"Words are labels—nothing more, nothing less—than concepts. A single concept, however, represents much more than the meaning of a single word" (Vacca & Vacca, 1996, p. 137). Although the use of context and the use of definitions are widely accepted methods for helping students learn new words, neither method is sufficient for developing the

relational knowledge necessary for in-depth understanding of concepts (e.g., Blachowicz & Fisher, 1996; Irvin, 1990). To develop conceptual understanding, vocabulary instruction should promote involvement of students and involve them in deep processing of words (e.g., McKeown & Beck, 1988; Irwin, 1990). Effective use of graphic organizers appears to meet both of these conditions exceptionally well.

Briefly stated, graphic organizers are two-dimensional visual arrays showing relationships among concepts (Rice, 1994). Their use is usually explained in terms of schema theory, which asserts that the human brain naturally organizes information into categories determined by past experience. New knowledge must be integrated with ideas in existing schema, or, in other words, prior knowledge (e.g., Dunston, 1992; Rumelhart, 1982).

> Although the connection between schema theory and graphic organizers is not explicitly stated in the existing research, the implication is that key vocabulary terms or concepts from a learning task that are graphically displayed can activate prior knowledge more instantaneously and completely than abstract prose .... Graphic organizers ... organize information to be learned, connect it to what is known, and allow the reader to interact with the text. (Dunston, 1992, p. 59)

Graphic organizers serve as retrieval cues for information (Dunston, 1992); they also facilitate higher level thinking (Clarke, 1991). Learner maturity may be a factor in their effectiveness (Moore & Readence, 1984); because they deal with relationships among concepts, they are probably more appropriate for use with students who have the cognitive development to think abstractly. Although originally designed to be used as "teacher-directed, prereading, instructional activities" (Dunston, 1992, p. 59), Moore and Readence

(1984) indicated that they may be more effective in post-reading situations. The need for discussion in conjunction with their use was emphasized by Naughton (1993-94). Student-constructed graphic organizers appeared to be more beneficial than those constructed by teachers (e.g., Bean, Singer, Sorter, & Frazee, 1986; Moore & Readence, 1984). Moore and Readence suggested that when students construct their own graphic organizers, they participate actively and process ideas themselves. Further, student-constructed graphic organizers allow for teacher observation of level of understanding so that instructional interventions may be provided (Naughton, 1993-94).

Using Graphic Organizers in Vocabulary Instruction in Mathematics

Graphic organizers have been found to be especially effective for teaching technical vocabulary (Moore & Readence, 1984, cited in Readence, Bean, & Baldwin, 1989); however, their use may be dependent upon an existing schema for the concept under study. In view of these considerations, Monroe and Pendergrass (1997) combined a discussion model for developing understanding of new words (Frayer, Frederick, & Klausmeier, 1969, cited in Blachowicz & Fisher, 1996) with Concept of Definition (Schwartz, 1988), a graphic form with similar features. This adapted model, called the integrated CD-Frayer model, was implemented with fourth graders in a measurement unit for 10 lessons during a 2-week period. The use of this model occurred at the end of the daily lesson in mathematics and involved collaborative student and teacher construction. The integrated CD-Frayer model was tested against a definition-only model; the CD-Frayer model appeared to be effective in increasing the use of mathematical vocabulary in fourth grade student writing.

Recommendations for Research

As is obvious from a review of literature, research on the use of graphic organizers in developing the vocabulary of mathematics is meager. Nonetheless, the need for vocabulary development in mathematics remains a crucial issue. Because graphic organizers have been found to be an effective strategy for vocabulary instruction in informational text, one might infer their usefulness in teaching mathematics vocabulary. In the opinion of this writer, the following questions deserve prompt attention:

1. Which research designs provide the most helpful information regarding the efficacy of graphic organizers in teaching mathematics vocabulary?

2. Which graphic organizers are effective, and to what extent, in teaching mathematics vocabulary? At what grade levels? How should they be used (e.g., before, during, or after instruction; daily or intermittently, etc.)?

3. How do graphic organizers "measure up" when compared with other methods of teaching mathematics vocabulary at various grade levels?

4. If graphic organizers are found to be effective in teaching mathematics vocabulary, what are some strategies for helping teachers learn to incorporate their use in instruction?

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